VERDIGRIS BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody: Walnut Creek
Water Quality Impairment: Dissolved Oxygen

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Upper Verdigris **County:** Greenwood

HUC 8: 11070101

HUC 11 (HUC 14s)**:** **030** (020, 030, 040 and 050)

Drainage Area: 166.7 square miles

Main Stem Segment: WQLS: 19 (Walnut Creek) starting at Toronto Lake and traveling upstream to headwaters in central Greenwood County (**Figure 1**).

Tributary Segments:
WQLS: Bachelor Creek (21)
Homer Creek (20)
Bernard Creek (24)
Non-WQLS: Fancy Creek (28)
Kuntz Branch (29)

Designated Uses: Expected Aquatic Life Support, Secondary Contact Recreation, and Food Procurement for Main Stem Segment 19.

Expected Aquatic Life Support, Secondary Contact Recreation, Domestic Water Supply and Food Procurement on listed Tributary Segments (21, 20 and 24)

1998 303(d) Listing: Table 1 - Predominant Non-point Source and Point Source Impacts

Impaired Use: Expected Aquatic Life Support

Water Quality Standard: Dissolved Oxygen (DO): 5 mg/L (KAR 28-16-28e(c)(2)(A))

2. CURRENT WATER QUALITY CONDITION AND DESIRED ENDPOINT

Level of Support for Designated Use under 1998 303(d): Not Supporting Aquatic Life

Monitoring Sites: Station 576 near Neal

Period of Record Used: 1990 through 2001 for Station 576 (**Figure 2**)

Flow Record: Verdigris River near Virgil (USGS Station 07165750) portioned to drainage area of Walnut Creek watershed.

Long Term Flow Conditions: 10% Exceedance Flows = 228 cfs**,** 95% = 0.85 cfs

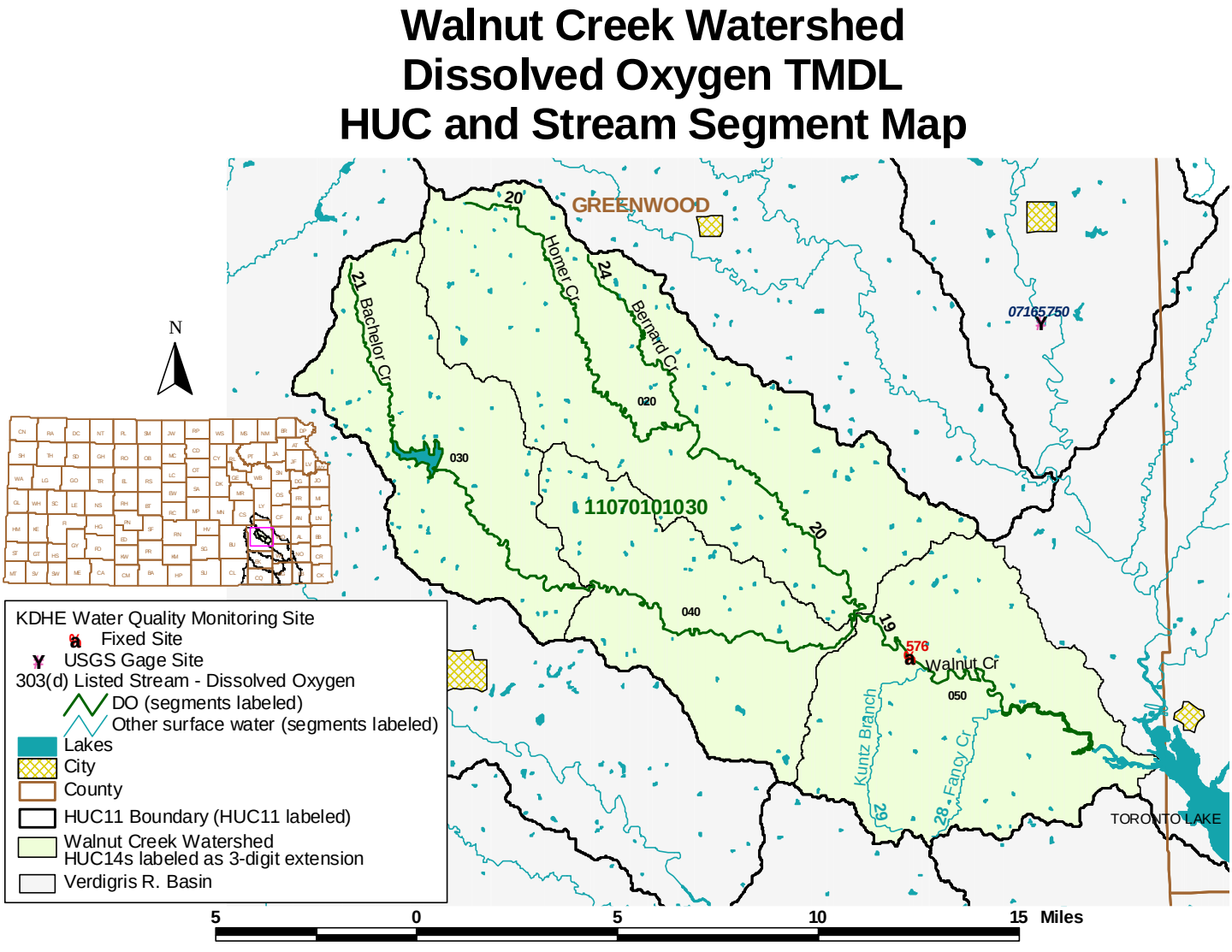

Figure 1

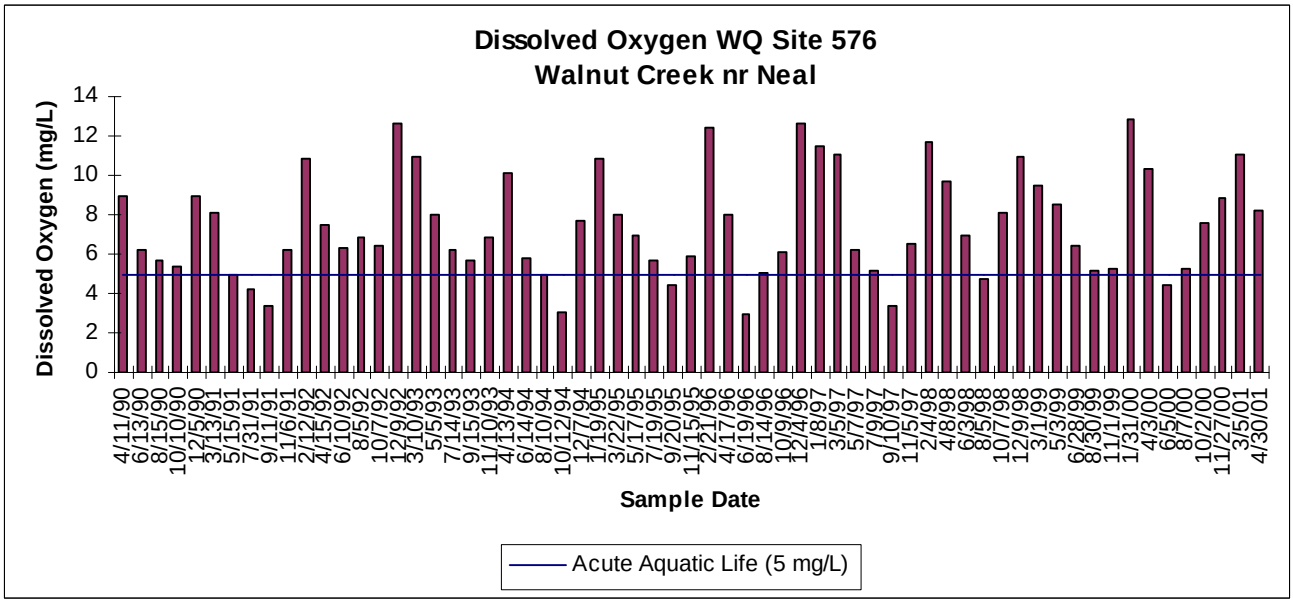

Figure 2

Current Conditions: Since loading capacity varies as a function of the flow present in the stream, this TMDL represents a continuum of desired loads over all flow conditions, rather than fixed at a single value. Sample data for the sampling site were categorized for each of the three defined seasons: Spring (Apr-Jul), Summer-Fall (Aug-Oct) and Winter (Nov-Mar). High flows and runoff equate to lower flow durations; baseflow and point source influences generally occur in the 75-99% range. Load curves were established for the Aquatic Life criterion by multiplying the flow values for Chetopa Creek near Neodesha along the curve by the applicable water quality criterion and converting the units to derive a load duration curve of pounds of DO per day. This load curve graphically displays the TMDL since any point along the curve represents water quality at the standard at that flow. Historic excursions from water quality standards (WQS) are seen as plotted points *below* the load curves. Water quality standards are met for those points plotting *above* the applicable load duration curves (**Figure 3**).

Excursions were seen two of the three defined seasons and are outlined in **Table 1**. Thirty three percent of the Summer-Fall samples and 14% of the Spring samples were below the aquatic life criterion. None of the Winter samples were under the aquatic life criterion. Overall, 14% of the samples were under the criterion. This would represent a baseline condition of partial support of the impaired designated use.

Most of the DO violations were encountered at flows less than 3.2 cfs on Walnut Creek near Neal, therefore a critical low flow can be identified on Walnut Creek as those flows of 3.2 cfs or less.

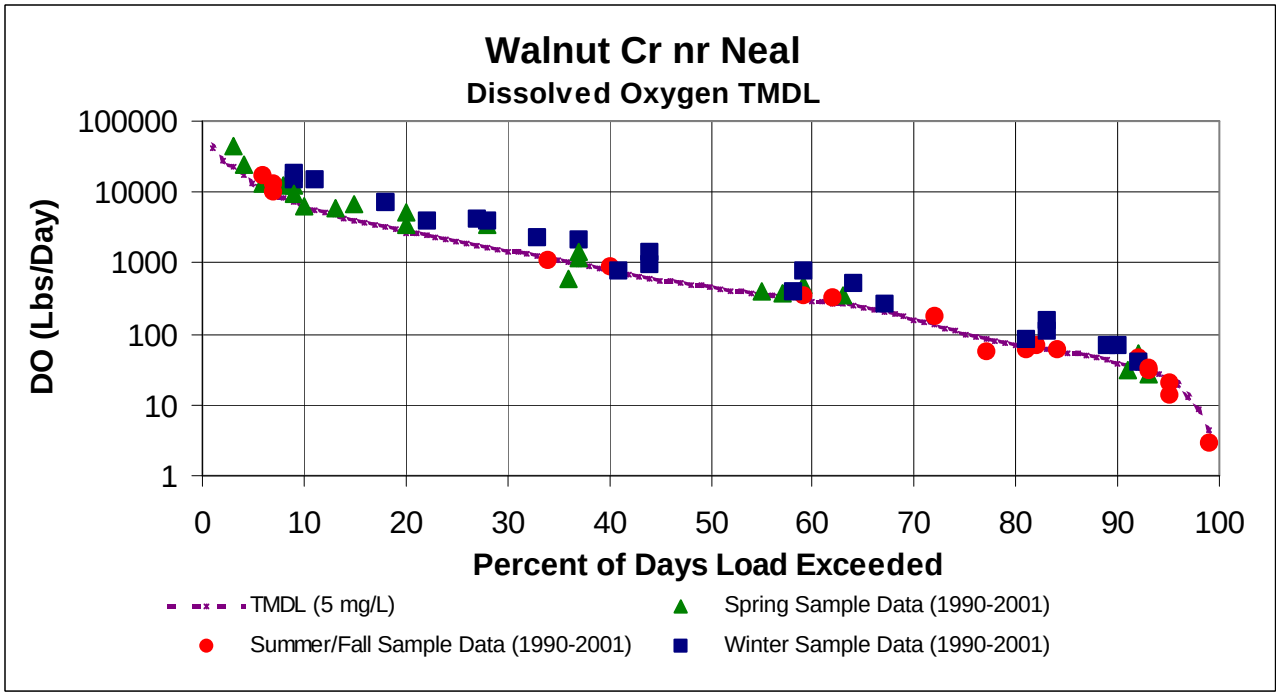

Figure 3

Table 1
NUMBER OF SAMPLES UNDER DISSOLVED OXYGEN STANDARD OF 5 mg/L BY FLOW

Station	Season	0 to 10%	10 to 25%	25 to 50%	50 to 75%	75 to 90%	90 to 100%	Cum Freq.
Walnut Creek near Neal (576)	Spring	0	0	1	0	0	2	3/22 = 14%
	Summer	0	0	1	0	2	3	6/18 = 33%
	Winter	0	0	0	0	0	0	0/23 = 0%

A watershed comparison approach was taken in developing this TMDL. The Otter Creek watershed (Water Quality Sampling Site 574 in the watershed was not impaired by low DO) has similar land use characteristics (**see Table 2 in Appendix**) to the Walnut Creek watershed, is of similar size and is located south of the Walnut Creek watershed in the Verdigris River Basin. The relationship of DO to ammonia, biochemical oxygen demand (BOD), fecal coliform bacteria (FCB), water temperature, turbidity, nitrate, phosphorus, pH and total suspended solids (TSS) were used in the comparison.

Table 3 in the Appendix outlines those water quality data for the samples taken on the same day for the two sites of interest. **Table 4 in the Appendix** is the subset of data from Table 3 for those sample dates when DO was below the aquatic life criterion for sample site 576. From Table 4 at site 576 the average ammonia and BOD were slightly higher than the reference cite, while all other parameters were slightly lower or about the same. For three of these comparison

dates (9/11/91, 6/19/96 and 8/5/98), even the reference site experienced low DO, although the degree of impairment was less at reference site 574.

In addition to the comparison provided in Table 4, there were three samples dates, 10/10/90, 4/17/96 and 8/30/99, at site 576 in Table 3 (**see italicized rows in Table 3**) when the flow was within the critical flow range yet DO was not violated. In two of these three instances, BOD was lower than the averages in Table 4.

From this comparison, because the BOD averages were higher at site 576, the indication is that , in addition to the naturally driven factor of lower flow which can contribute to the occasional DO excursions, a probable oxygen demanding substance load is being added to the Walnut Creek watershed upstream of site 576 and, under certain conditions, is likely a factor influencing the DO violations.

Desired Endpoints of Water Quality at Site 576 over 2007 - 2011

The desired endpoint will be a biochemical oxygen demand from artificial sources such that average BOD concentrations remain below 2.7 mg/l in the stream under the critical flow conditions which results in no excursions below 5 mg/l of DO detected between 2007 - 2011 attributed to these sources.

This desired endpoint should improve DO concentrations in the creek at the critical lower flows (0 - 3.2 cfs). Seasonal variation is accounted for by this TMDL, since the TMDL endpoint is sensitive to the low flow usually occurring in the June - October months.

This endpoint will be reached as a result of expected, though unspecified, reductions in organic loading from the various sources in the watershed resulting from implementation of corrective actions and Best Management Practices, as directed by this TMDL (see Implementation - Section 5). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows which, in turn, should help reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period. Achievement of this endpoint will provide full support of the aquatic life function of the creek and attain the dissolved oxygen water quality standard.

3. SOURCE INVENTORY AND ASSESSMENT

NPDES: There are no NPDES permitted wastewater dischargers within the watershed that would contribute an oxygen demanding substance load to monitoring site 576.

Livestock Waste Management Systems: Five operations are registered, certified or permitted within the watershed. These facilities (dairies or swine facilities) tend to be located toward the lower half of watershed (**Figure 4**). All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detaining runoff emanating from their areas. Such systems are designed for the 25 year, 24 hour rainfall/runoff event, which typically coincide with stream flows exceeded less than 1 - 5 % of the time. NPDES permits, also

non-discharging, are issued for facilities with more than 1,000 animal units. None of the facilities in the watershed are of this size. Total potential animal units for all these facilities is 1,177. The actual number of animal units on site is variable, but typically less than potential numbers.

Land Use: Most of the watershed is grassland (92% of the area), cropland (5%), or woodland (2%). The cropland is located near the stream channels in the watershed. The grazing density estimate is average for the watershed when compared to densities elsewhere in the Verdigris Basin (36 animal units/mi^2) (**Figure 5 or Table 2 in Appendix**).

On-Site Waste Systems: The watershed's population density is low to average when compared to densities across the Verdigris Basin (2-11 person/mi^2) (**Figure 5**). The rural population projections for Greenwood county through 2020 indicate significant growth (27% increase). While failing on-site waste systems can contribute oxygen demanding substance loadings, their impact on the impaired segments is generally limited, given the small size of the rural population and magnitude of other sources in the watershed.

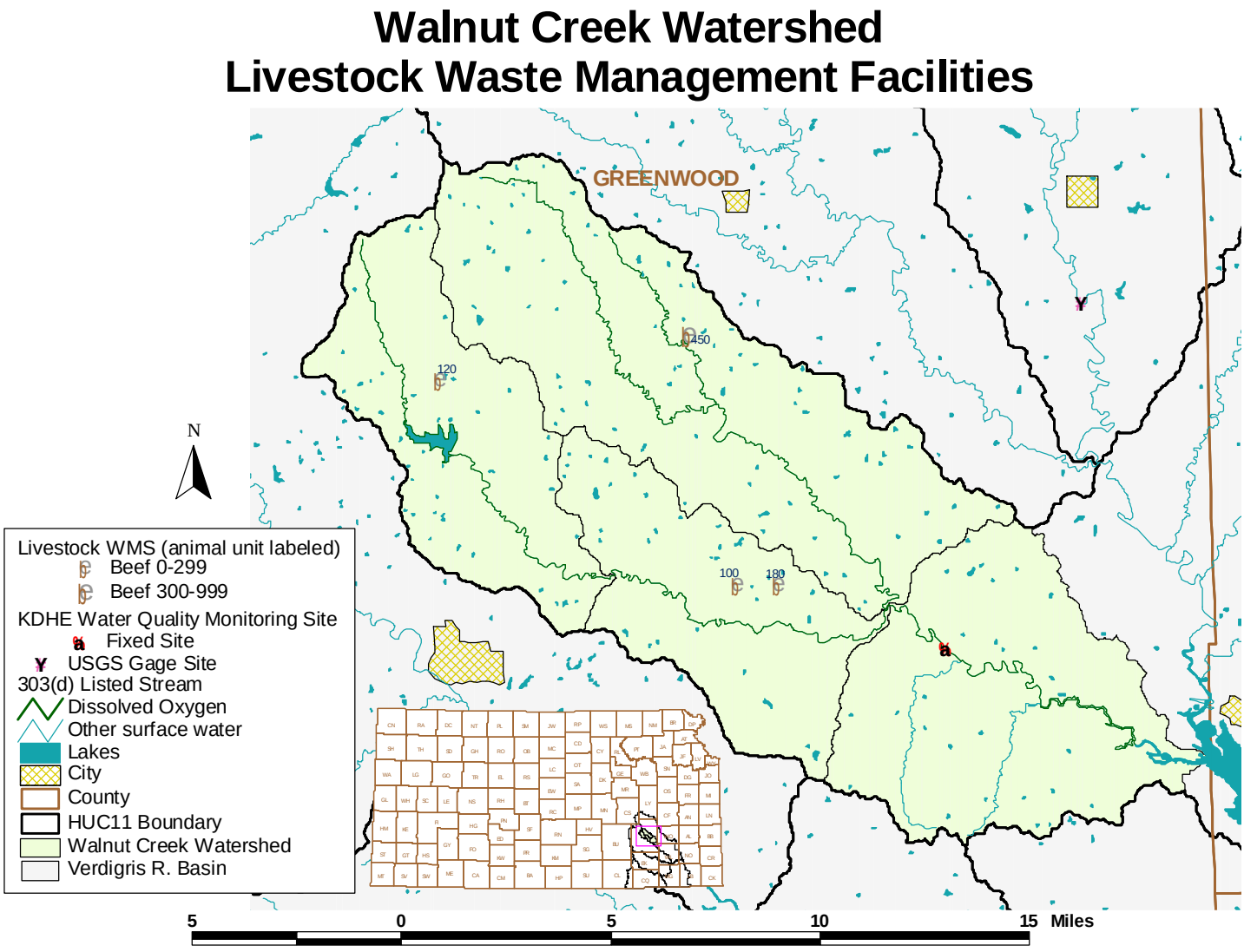

Figure 4

Walnut Creek Watershed
Land Use, Population and Grazing Density

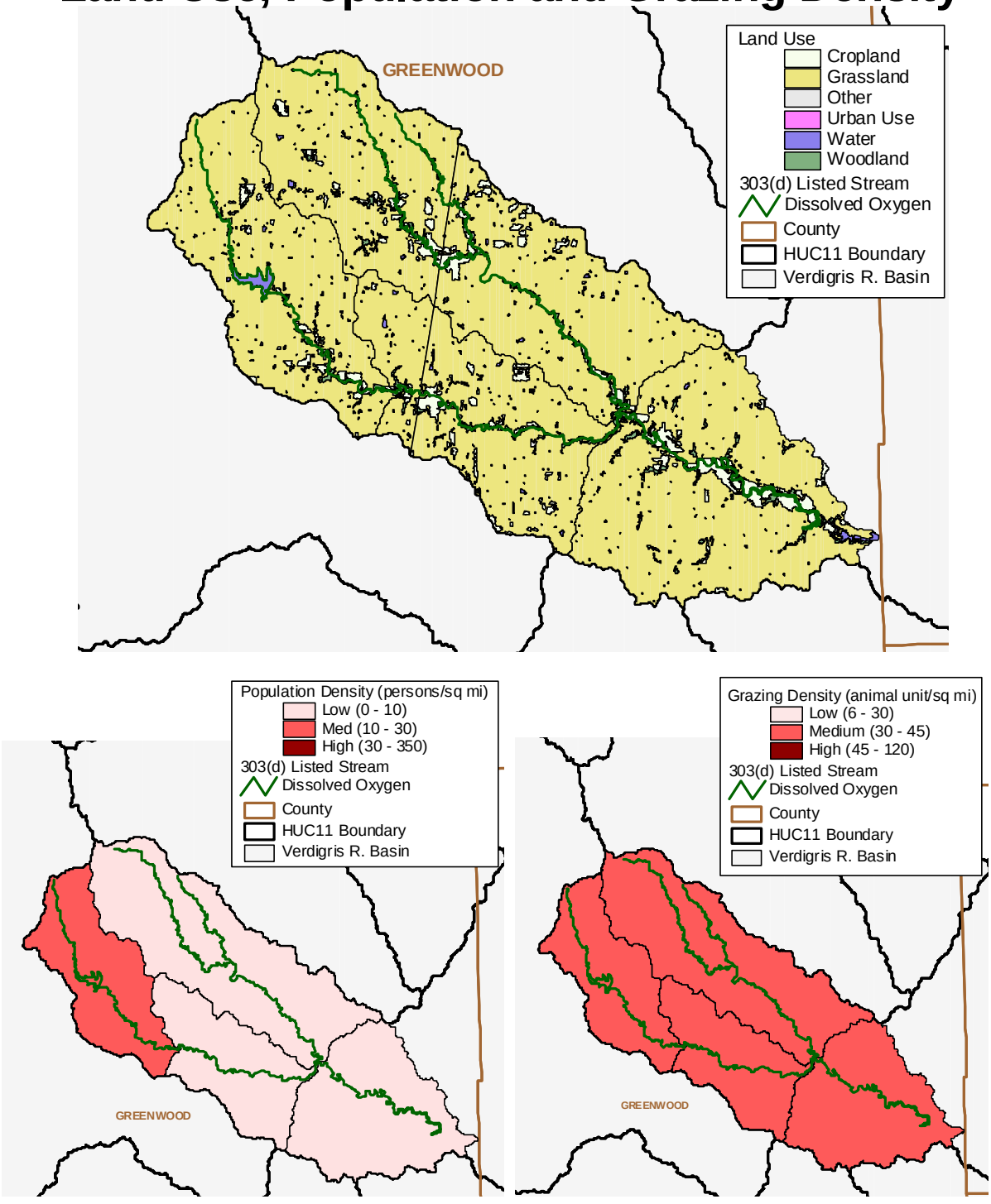

Figure 5

Contributing Runoff: The Walnut Creek watershed's average soil permeability is 0.5 inches/hour according to NRCS STATSGO data base. Practically all of the watershed produces runoff even under relatively low (1.71"/hr) potential runoff conditions (99.7%). Under very low (1.14"/hr) potential conditions, this potential contributing area is reduced to about 94%. Runoff is chiefly generated as infiltration excess with rainfall intensities greater than soil permeabilities. As the watersheds' soil profiles become saturated, excess overland flow is produced. Generally, storms producing less than 0.57"/hr of rain will still generate runoff from 82% of this watershed.

Background Levels: Some organic enrichment may be associated with environmental background levels, including contributions from wildlife and stream side vegetation, but it is likely that the density of animals such as deer is fairly dispersed across the watershed and that the loading of oxygen demanding material is constant along the stream. In the case of wildlife, this loading should result in minimal loading to the streams below the levels necessary to violate the water quality standards. In the case of stream side vegetation, the loading should be greater in the lower half of the watershed with its larger proportion of woodland near the stream.

4. ALLOCATION OF POLLUTION REDUCTION RESPONSIBILITY

BOD is a measure of the amount of oxygen required to stabilize organic matter in a stream. As such, BOD is used as a benchmark measure to anticipate DO levels while it measures the total concentration of DO that will be demanded as organic matter degrades in a stream. It is presumed that reductions in BOD loads will reduce DO excursions under certain critical flow conditions. Therefore, any allocation of wasteloads and loads will be made in terms of BOD reductions. Yet, because DO is a manifestation of multiple factors, the initial pollution load reduction responsibility will be to decrease the BOD over the critical range of flows encountered on the Walnut Creek system. These reductions have been based on the relationship between DO and BOD for the samples taken at Water Quality Monitoring site 576 as compared to the reference Otter Creek watershed and its water quality monitoring site 574. Allocations relate to the BOD levels seen in the Walnut Creek system at site 576 relative to site 574 for the critical lower flow conditions (0-3.2 cfs). Based on this relationship, BOD loads at site 576 need to be reduced by 15% (so that in stream average BOD is 2.7 mg/L or less). Additional monitoring over time will be needed to further ascertain the relationship between BOD reductions of non-point sources, flow conditions, and DO levels along the stream.

For this phase of the TMDL the average condition is considered across the seasons to establish goals of the endpoint and desired reductions. Therefore, the target average BOD level was multiplied by the average daily flow for Walnut Creek across all hydrologic conditions. This is represented graphically by the integrated area under the BOD load duration curve established by this TMDL. Any future growth or development in wasteloads should be offset by reductions in the loads contributed by non-point sources. This offset along with appropriate limitations is expected to eliminate the impairment. This TMDL represents the "Best Professional Judgment" as to the expected relationship between physical factors, organic matter and DO.

Point Sources: A current Wasteload Allocation of zero is established by this TMDL because of the lack of discharging point sources in the watershed. Should future point sources be proposed in the watershed and discharge into the impaired segments, the current Wasteload Allocation will be revised by adjusting current load allocations to account for the presence and impact of these new point source dischargers (**Figure 6**).

Non-Point Sources: Based on the prior assessment of sources, the distribution of excursions from water quality standards at site 576 and the relationship of those excursions to runoff conditions and seasons, non-point sources are seen as a contributing factor to the occasional DO excursions in the watershed.

The samples from the Walnut Creek watershed show that DO violations occurred at flows primarily below 3.2 cfs. The Load Allocation assigns responsibility for reducing the in stream BOD levels at site 576 to 2.7 mg/L across the 0.0 - 3.2 cfs range of the critical flow condition (77 - 99% exceedance) and maintaining the in stream BOD levels at site 576 to the historical levels of 4.3 mg/L for flows in excess of 3.2 cfs (which is 90th percentile of BOD samples for flows in Walnut Creek above 3.2 cfs near Neal)(**Figure 6**). Sediment control practices such as buffer strips and grassed waterways should help reduce the non-point source BOD load under higher flows as well as reduce the oxygen demand exerted by the sediment transported to the stream that may occur during the critical flow period.

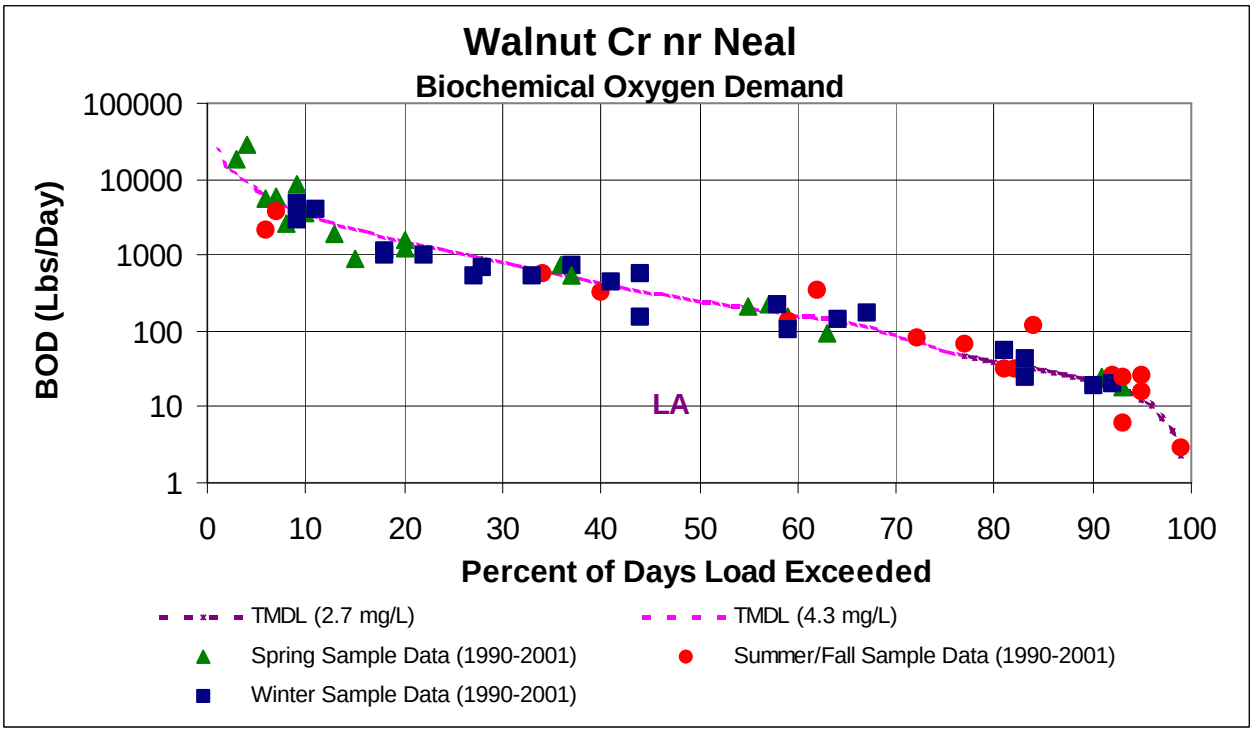

Figure 6

Defined Margin of Safety: The Margin of Safety will be implied based on conservative assumptions used to set the target BOD concentration, since sampling data indicates exceeding

this value has seldom led to a dissolved oxygen violation.

State Water Plan Implementation Priority: Because this watershed's incidence of exceedance from the dissolved oxygen standard is relatively low when compared to other watersheds impaired by low dissolved oxygen within the Verdigris basin, this TMDL will be a Medium Priority for implementation.

Unified Watershed Assessment Priority Ranking: This watershed lies within the Upper Verdigris Basin (HUC 8: 11070101) with a priority ranking of 57 (Low Priority for restoration work).

Priority HUC 11s and Stream Segments: Priority should be directed toward baseflow gaining stream segments along the main stem of Walnut Creek (19).

5. IMPLEMENTATION

Desired Implementation Activities

1. None, unless impairment is confirmed by additional monitoring between 2003- 2007.

Implementation Programs Guidance

Unless impairment is confirmed by additional monitoring between 2003- 2007, no direction is needed on implementation programs.

Time frame for Implementation: Conditions will be evaluated based additional on monitoring between 2003- 2007.

Targeted Participants: None, until 2007 evaluation.

Milestone for 2007: The year 2007 marks the midpoint of the ten-year implementation window for the watershed. At that point in time, additional monitoring data from Station 576 will be reexamined to confirm the impaired status of the streams within this watershed. Should the case of impairment develop, source assessment, allocation and implementation activities will ensue.

Delivery Agents: None at this time. Status will be re-evaluated in 2007.

Reasonable Assurances:

Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution.

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the waters of the state.

2. K.S.A. 65-171d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.A.R. 28-16-69 to -71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

4. K.S.A. 2-1915 empowers the State Conservation Commission to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

5. K.S.A. 75-5657 empowers the State Conservation Commission to provide financial assistance for local project work plans developed to control non-point source pollution.

6. K.S.A. 82a-901, *et seq*. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

7. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the *Kansas Water Plan.*

8. The *Kansas Water Plan* and the Verdigris Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority in implementation.

Funding: The State Water Plan Fund, annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the *Kansas Water Plan*. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watersheds and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This TMDL is a Medium Priority consideration.

Effectiveness: Improvements in reducing oxygen demanding substance loading to streams can be accomplished through appropriate management and control systems, including buffer strips and riparian restoration projects.

6. MONITORING

KDHE will continue to collect bimonthly samples at Station 576, over each of the three defined seasons. Based on that sampling, the priority status of 303(d) listing will be evaluated in 2006. Should impaired status remain, the desired endpoints under this TMDL will be refined and implementation activities within the watershed will occur. Direct more intensive sampling may need to be conducted under specified low flow conditions over the period 2007-2011 to assess

progress and success in implementing this TMDL.

7. FEEDBACK

Public Meetings: Public meetings to discuss TMDLs in the Verdigris Basin were held January 23 in Fredonia and March 6, 2002 in Neodesha. An active Internet Web site was established at http://www.kdhe.state.ks.us/tmdl/ to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Verdigris Basin.

Public Hearing: A Public Hearing on the TMDLs of the Verdigris Basin was held in Neodesha on June 4, 2002.

Basin Advisory Committee: The Verdigris Basin Advisory Committee met to discuss the TMDLs in the basin on October 3, 2001, January 23 and March 6, 2002.

Milestone Evaluation: In 2007, evaluation will be made as to the degree of impairment which has occurred within the watershed and current condition of Walnut Creek. Subsequent decisions will be made regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The stream will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2007-2011. Therefore, the decision for delisting will come about in the preparation of the 2012 303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and the Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision will come in 2003 which will emphasize implementation of TMDLs. At that time, incorporation of this TMDL will be made into both documents. Recommendations of this TMDL will be considered in *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2003-2007.

Appendix (Walnut Creek DO TMDL)

Table 2

Walnut Cr Wtrshed (576)			Otter Creek Wtrshd (574)		
Land Use	Acres	% of Total	Land Use	Acres	% of Total
Cropland	5125	4.8	Cropland	4394	5.6
Grassland	97706	91.6	Grassland	69690	89.1
Urban Use	19	0.0	Urban Use	0	0.0
Water	1273	1.2	Water	609	0.8
Woodland	2569	2.4	Woodland	3496	4.5
Total	106693	100	Total	78190	100

Table 3

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		FLOW
	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576
4/11/90	9.0	9.7	0.010	0.010	3.40	0.01	2700	200	0.11	0.23	8.0	8.1	11	11	0.110	0.020	96	17	51.0	8.4	262.87
6/13/90	6.2	6.0	0.000	0.000	2.50	2.10	400	400	0.27	0.43	8.1	8.1	24	25	0.050	0.050	40	52	17.8	25.2	400.72
8/15/90	5.7	7.0	0.050	0.010	2.10	3.00	440	180	0.16	0.18	7.7	8.1	22	22	0.110	0.060	60	31	54.2	19.6	28.85
10/10/90	*5.4*	*7.8*	*0.080*	*0.030*	*2.40*	*3.10*	*40*	*60*	*0.06*	*0.03*	*7.8*	*8.0*	*12*	*11*	*0.050*	*0.030*	*32*	*14*	*23.2*	*12.0*	2.40
12/5/90	8.9	10.7	0.000	0.000	2.40	2.90	50	10	0.01	0.00	9.7	8.3	3	2	0.030	0.020	8	5	5.1	3.7	1.50
3/13/91	8.1	9.2	0.000	0.020	-----	3.20	20	10	0.01	0.02	8.1	8.2	7	7	0.050	0.030	26	17	14.1	10.4	1.60
5/15/91	5.0	6.3	0.000	0.000	2.90	4.70	170	80	0.06	0.04	7.9	8.1	22	22	0.050	0.070	14	33	9.4	19.0	230.28
7/31/91	**4.2**	5.0	0.000	0.000	3.50	4.40	100	100	0.05	0.24	7.9	7.9	25	24	0.060	0.110	19	51	12.0	36.9	1.34
9/11/91	**3.4**	4.2	0.000	0.000	3.30	2.80	100	100	0.11	0.11	7.9	7.9	25	25	0.070	0.060	21	17	17.5	12.1	0.16
2/12/92	10.8	11.3	0.000	0.000	3.90	2.50	800	70	0.15	0.13	7.9	8.1	3	3	0.050	0.050	10	13	6.8	7.9	35.80
4/15/92	7.5	7.6	0.050	0.050	2.90	2.00	160	100	0.02	0.03	8.1	8.2	17	19	0.050	0.050	21	19	11.4	12.0	34.73
6/10/92	6.3	6.5	0.050	0.050	5.90	6.20	25000	25000	0.19	0.42	6.3	7.7	19	19	0.780	0.800	584	976	383.0	464.0	273.56
8/5/92	6.8	6.9	0.050	0.050	2.00	2.20	3200	1800	0.09	0.26	7.9	7.9	21	20	0.110	0.150	111	96	55.0	58.6	350.50
10/7/92	6.4	8.0	0.050	0.050	3.00	2.46	50	100	0.02	0.14	7.8	7.9	15	15	0.050	0.050	16	21	11.0	9.3	5.13
12/9/92	12.6	12.2	0.050	0.050	1.90	1.70	1100	100	0.20	0.54	-----	-----	0	2	0.050	0.050	31	27	21.0	20.0	280.50
3/10/93	11.0	10.8	0.050	0.050	1.80	1.10	70	30	0.19	0.38	8.1	8.2	8	7	0.050	0.050	27	19	10.0	5.0	118.61
5/5/93	8.0	8.6	0.050	0.050	1.70	1.20	600	460	0.23	0.42	8.0	8.0	16	15	0.110	0.060	54	76	34.0	26.0	287.98
7/14/93	6.2	6.6	0.050	0.050	2.80	3.60	600	60000	0.22	0.56	8.1	8.0	25	24	0.090	0.190	18	88	15.0	29.0	104.72
9/15/93	5.7	7.6	0.100	0.050	2.20	1.70	100	100	0.46	0.67	7.9	7.9	16	15	0.100	0.080	30	20	18.0	10.0	11.22
11/10/93	6.8	9.6	0.050	0.050	4.30	4.00	30	10	0.07	0.27	7.6	7.7	4	4	0.070	0.050	8	11	5.0	4.0	7.48
4/13/94	10.1	10.3	0.050	0.050	4.20	3.30	4300	1500	0.29	0.39	7.9	7.9	7	7	0.150	0.070	96	62	63.0	34.0	801.44
6/14/94	5.8	6.8	0.050	0.050	3.30	3.20	300	2300	0.03	0.29	8.0	8.0	23	23	0.050	0.050	10	22	3.0	8.0	12.29
8/10/94	**4.9**	7.6	0.010	0.010	6.20	9.40	10	400	0.01	0.11	7.9	8.0	24	23	0.050	0.080	18	34	8.0	9.0	0.80
10/12/94	**3.1**	5.8	0.010	0.010	3.70	3.30	600	500	0.01	0.01	7.6	7.8	13	12	0.020	0.010	9	17	5.0	7.0	0.80
12/7/94	7.7	10.5	0.100	0.060	4.60	3.90	14700	20	0.34	0.40	7.6	7.9	3	2	0.100	0.010	19	9	20.0	4.0	22.97
1/19/95	10.8	11.9	0.010	0.010	3.00	1.70	100	100	0.01	0.17	7.8	8.1	2	2	0.020	0.010	6	2	3.0	2.0	9.08
3/22/95	8.0	8.9	0.010	0.010	2.00	1.40	50	100	0.06	0.17	7.1	8.1	14	14	0.060	0.040	34	22	18.0	6.0	92.43
5/17/95	6.9	8.0	0.080	0.120	7.90	7.60	60000	60000	0.12	0.25	7.9	7.6	16	17	1.080	1.410	1130	1360	197.0	157.0	651.84
7/19/95	5.7	6.8	0.010	0.010	2.90	2.40	100	100	0.08	0.34	7.9	7.9	24	24	0.050	0.060	15	31	3.0	13.0	13.36
9/20/95	**4.4**	7.5	0.440	0.230	2.40	2.00	30	500	0.14	0.55	7.7	7.9	18	17	0.070	0.041	38	22	14.0	8.0	2.51
11/15/95	5.9	11.4	0.030	0.036	2.90	1.20	100	10	0.04	0.15	7.8	7.8	5	5	0.040	0.013	10	7	3.0	2.0	1.28
2/21/96	12.4	11.5	0.050	0.054	3.50	3.20	3	1	0.06	0.25	7.8	7.7	4	4	0.040	0.035	11	15	5.5	6.1	2.30
4/17/96	*8.0*	*10.0*	*0.030*	*0.028*	*3.60*	*5.10*	*71*	*100*	*0.04*	*0.06*	*8.0*	*8.1*	*14*	*12*	*0.050*	*0.030*	*16*	*18*	*9.0*	*5.0*	1.23
6/19/96	**3.0**	4.8	0.160	0.083	3.60	3.30	110	1000	0.10	0.26	7.6	7.6	23	22	0.090	0.208	35	128	16.0	96.0	36.87
8/14/96	5.1	9.6	0.150	0.120	10.10	7.50	60	50	0.09	0.01	7.8	8.1	22	22	0.160	0.095	27	38	10.0	14.0	2.14
10/9/96	6.1	7.8	0.490	0.308	6.20	6.00	400	300	0.07	0.08	7.6	8.0	14	14	0.110	0.070	44	37	27.0	17.0	10.15
12/4/96	12.6	13.0	0.020	0.020	3.50	3.10	790	400	0.16	0.26	7.9	8.0	4	4	0.130	0.078	41	20	43.0	30.0	215.86
1/8/97	11.5	12.6	0.020	0.020	1.29	1.00	10	50	0.07	0.15	7.8	8.0	4	4	0.020	0.012	3	2	3.5	2.7	22.44
3/5/97	11.1	11.3	0.020	0.020	1.59	1.00	50	30	0.22	0.32	8.0	7.9	7	6	0.070	0.020	19	10	23.0	5.0	118.61
5/7/97	6.2	8.4	0.020	0.020	3.93	2.16	40	40	0.06	0.19	7.8	7.9	19	18	0.010	0.010	19	8	7.7	3.3	34.19
7/9/97	5.2	6.2	0.020	0.020	3.03	2.91	300	2300	0.08	0.13	7.7	7.8	25	25	0.090	0.319	50	260	22.0	86.0	359.58
9/10/97	**3.4**	6.8	0.020	0.020	3.87	1.14	60	300	0.07	0.25	7.6	7.7	23	22	0.090	0.050	27	15	19.0	13.0	3.15
11/5/97	6.5	8.2	0.020	0.020	3.60	2.67	20	110	0.14	0.11	7.8	7.8	10	9	0.050	0.060	11	11	5.6	5.4	11.75
2/4/98	11.7	11.7	0.020	0.020	2.07	1.08	20	20	0.11	0.17	8.0	8.1	4	4	0.010	0.010	9	7	6.2	3.4	63.58
4/8/98	9.7	9.9	0.020	0.020	2.19	1.35	100	390	0.07	0.16	8.1	8.1	13	13	0.054	0.034	30	19	18.0	10.0	101.52
6/3/98	6.9	7.9	0.020	0.020	1.83	1.32	60	230	0.12	0.24	7.8	7.9	26	26	0.060	0.050	12	20	7.5	9.0	9.62
8/5/98	**4.7**	4.9	0.020	0.030	2.43	1.77	400	1300	0.19	0.39	7.7	7.7	25	25	0.090	0.100	31	46	18.0	32.0	43.81
10/7/98	8.1	7.8	0.020	0.020	1.00	1.26	430	390	0.19	0.34	7.8	7.9	17	17	0.094	0.067	25	34	22.0	21.0	397.99
12/9/98	11.0	11.0	0.020	0.020	3.57	3.90	4900	2100	0.22	0.39	7.9	7.8	8	8	0.090	0.050	18	15	20.0	9.0	247.89
3/1/99	9.5	10.8	0.030	0.040	2.31	2.34	20	30	0.07	0.23	8.1	8.0	10	11	0.040	0.030	13	8	7.7	3.0	44.35
5/3/99	8.5	8.8	0.020	0.020	1.11	1.00	90	180	0.26	0.34	7.9	8.1	18	18	0.040	0.030	23	11	11.0	5.0	146.69
6/28/99	6.4	6.9	0.020	0.020	1.98	1.71	1100	3700	0.23	0.55	8.0	7.9	26	25	0.050	0.140	33	114	48.0	55.0	172.84
8/30/99	*5.2*	*7.3*	*0.020*	*0.020*	*1.00*	*1.00*	*50*	*30*	*0.10*	*0.35*	*7.7*	*7.7*	*26*	*26*	*0.060*	*0.040*	*11*	*20*	*7.8*	*9.0*	1.14
11/1/99	5.3	6.5	0.029	0.020	3.12	3.72	320	2400	0.04	0.06	7.7	7.8	16	16	0.107	0.074	14	12	8.3	4.8	27.29
1/31/00	12.8	13.5	0.020	0.020	1.71	1.26	10	10	0.01	0.37	8.0	8.1	2	2	0.040	0.020	5	4	2.4	2.3	11.37
4/3/00	10.3	10.2	0.020	0.020	2.25	2.31	60	80	0.08	0.16	8.2	8.2	13	12	0.050	0.030	26	16	12.2	6.2	61.40
6/5/00	**4.4**	8.5	0.020	0.020	2.97	3.15	10	50	0.12	0.25	7.9	8.1	23	23	0.050	0.050	12	23	3.3	4.8	1.14
8/7/00	5.3	7.6	0.020	0.020	4.05	2.85	40	180	0.01	0.34	7.8	7.8	28	28	0.050	0.050	13	13	5.8	6.7	1.14
10/2/00	7.6	8.6	0.030	0.020	4.35	3.99	120	40	0.02	0.12	8.1	7.8	19	19	0.062	0.033	16	14	6.8	6.0	1.14
11/27/00	8.8	11.9	0.020	0.020	2.01	1.00	20	10	0.28	0.50	7.5	7.9	6	5	0.070	0.020	6	8	4.9	2.1	2.27
Avg	7.4	8.7	0.048	0.038	3.15	2.81	2095	2838	0.12	0.25	7.9	7.9	15	15	0.095	0.094	54	69	25.2	25.3	103.4

Table 4

COL_DATE	DISOXY		AMMONIA		BOD		FECCOLI		NITRATE		PHFIELD		TEMP_CENT		PHOSPHU		TSS		TURBIDITY		FLOW
	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576	574	576
7/31/91	**4.2**	5.0	0.000	0.000	3.50	4.40	100	100	0.05	0.24	7.9	7.9	25	24	0.060	0.110	19	51	12.0	36.9	1.34
9/11/91	**3.4**	**4.2**	0.000	0.000	3.30	2.80	100	100	0.11	0.11	7.9	7.9	25	25	0.070	0.060	21	17	17.5	12.1	0.16
8/10/94	**4.9**	7.6	0.010	0.010	6.20	9.40	10	400	0.01	0.11	7.9	8.0	24	23	0.050	0.080	18	34	8.0	9.0	0.80
10/12/94	**3.1**	5.8	0.010	0.010	3.70	3.30	600	500	0.01	0.01	7.6	7.8	13	12	0.020	0.010	9	17	5.0	7.0	0.80
9/20/95	**4.4**	7.5	0.440	0.230	2.40	2.00	30	500	0.14	0.55	7.7	7.9	18	17	0.070	0.041	38	22	14.0	8.0	2.51
6/19/96	**3.0**	**4.8**	0.160	0.083	3.60	3.30	110	1000	0.10	0.26	7.6	7.6	23	22	0.090	0.208	35	128	16.0	96.0	36.87
9/10/97	**3.4**	6.8	0.020	0.020	3.87	1.14	60	300	0.07	0.25	7.6	7.7	23	22	0.090	0.050	27	15	19.0	13.0	3.15
8/5/98	**4.7**	**4.9**	0.020	0.030	2.43	1.77	400	1300	0.19	0.39	7.7	7.7	25	25	0.090	0.100	31	46	18.0	32.0	43.81
6/5/00	**4.4**	8.5	0.020	0.020	2.97	3.15	10	50	0.12	0.25	7.9	8.1	23	23	0.050	0.050	12	23	3.3	4.8	1.14
Avg	3.9	6.1	0.096	0.056	3.22	2.73	187	536	0.11	0.26	7.8	7.8	22	21	0.069	0.074	25	38	13.3	24.7	10.1